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Personality and Memory

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Synonyms

Anxiety; Emotion regulation; Emotional distraction; Emotional memory; Neuroticism; Reappraisal; Suppression

Definition

Relationships between personality traits and emotion-memory interactions

Introduction

Personality influences our emotions, thoughts, and memories. The salience of our emotional experiences, the valence of emotional memories we recall, and how we dwell on these memories are influenced by the unique characteristics that define us as individuals. Indeed, empirical evidence suggests a critical impact of emotion on cognition and a high variability of these effects between individuals with different personality traits (Haas and Canli 2008). The focus here is on the role of personality traits in the impact of emotion on memory. It is well established that emotional events are better remembered than neutral ones and that this effect is typically observed in relation to long-term *episodic memory* (EM) – i.e., memory for specific events experienced in everyday life (Dolcos et al. 2012). However, emotions can also interfere with *working memory* (WM) – i.e., temporary maintenance and manipulation of information – when emotions are presented as distraction that interferes with one's focus on the task at hand (Iordan et al. 2013).

Importantly, these opposing effects of emotion on memory can be influenced by chronically activated biases in attention and emotion processing associated with more general personality traits. For instance, *extraversion*, a personality trait characterized by sociability and a tendency to experience more positive affect (John and Srivastava 1999), is associated with biases toward positive information (Derryberry and Reed 1994). In contrast, *neuroticism* and *anxiety*, personality traits characterized by heightened sensitivity and reactivity to negative emotional stimuli (Ormel et al. 2013), typically reflecting responses to challenging situations eliciting perceived or anticipated stress, are associated with biases toward negative information (MacLeod and Mathews 1988; Reed

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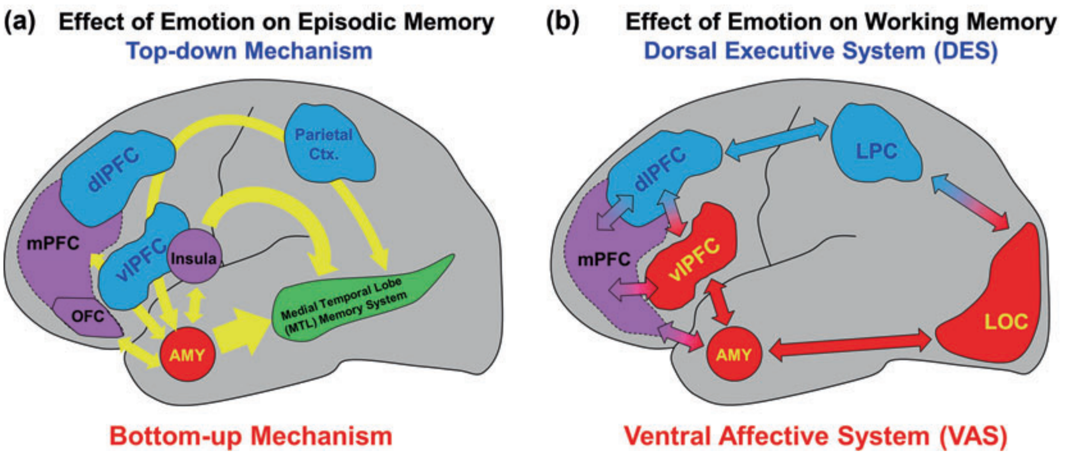
and Derryberry 1995). Of note, these biases can also be modulated by specific personality traits, such as habitual engagement of *emotion regulation* (ER) – i.e., the processes influencing which, when, and how emotions are experienced and expressed (Gross and John 2003). Advancements of brain imaging methods such as functional magnetic resonance imaging (fMRI), which noninvasively measures changes in brain activity with excellent precision about their location, have led to important progress in clarifying the relationships between personality and brain activity associated with the enhancing and the impairing effects of emotion on memory (Haas and Canli 2008; Iordan et al. 2013). Elucidating how personality-related differences influence emotions and their effects on memory is essential, given their implications for better understanding the mechanisms of dysfunctional emotion-cognition interactions, typically observed in affective disorders such as anxiety and depression. The present review discusses evidence showing how personality traits modulate the impact of emotion on EM and WM, with an emphasis on the associated neural mechanisms. The first section discusses basic evidence regarding the effect of emotion on EM and WM in healthy functioning. The second section focuses on evidence regarding the role of (1) more general (extraversion, neuroticism, anxiety) and (2) specific (ER strategies: *reappraisal and suppression*) personality traits.

Enhancing vs. Impairing Effects of Emotion on Episodic and Working Memory

Decades of research have shown that recollection of episodic experiences involves three stages of memory processing: encoding, storage/consolidation, and retrieval (Melton 1963; Morris 2013). When we experience a particular event, a memory representation for the event is first created, resulting in a pattern of neural activity (encoding). This newly formed memory representation is fragile at first and becomes more permanent and resistant to interference over time through stabilization in distinct neural circuits and integration with preexisting long-term memories (storage/consolidation). The memory for the event can then be subsequently accessed (retrieval), allowing us to recall or recognize the details associated with the original event, even after an extended period. Although these EM stages are associated with different neural mechanisms, available evidence highlights a pivotal role of structures within the medial temporal lobe (MTL), particularly the hippocampus (HC) (Morris 2013). In contrast, WM is primarily mediated by the frontal regions of the brain and is part of a larger neural system that supports aspects of decision-making and the planning of actions (Morris 2013).

Extant research shows that emotions can influence the processes related to both EM and WM. For instance, emotional events are typically better and more vividly remembered than neutral events (Phelps 2004). This *memory-enhancing effect of emotion* has been identified at various stages of memory, from early encoding and consolidation of memory traces to their later retrieval, typically with respect to the two orthogonal properties of emotional events: arousal (from *calm* to *excited*) and valence (from *unpleasant* to *pleasant*) (LaBar and Cabeza 2006). At the neural level, two mechanisms are mainly involved in the memory-enhancing effect of emotion – one based in the MTL (e.g., the HC and the amygdala [AMY]) and the other outside the MTL, involving regions such as the prefrontal cortex (PFC) (Dolcos et al. 2012) (Fig. 1a). On the one hand, the AMY (typically involved in basic emotion processing) and the HC interact through bottom-up neurohormonal mechanisms contributing to the memory-enhancing effect of emotion during encoding, consolidation, and retrieval of emotional memories (LaBar and Cabeza 2006). On the other hand, the PFC is part of a top-down mechanism that facilitates the formation of emotional memories by enhancing semantic (i.e., the meaning of events to be remembered), WM, and attentional processes (Dolcos et al. 2012).

The *memory-impairing effect of emotion* affects mainly WM, particularly when emotion is presented as a distracter irrelevant to the task at hand (Dolcos and McCarthy 2006), although



Personality and Memory, Fig. 1 Brain imaging investigations of the mechanisms associated with the enhancing and the impairing effects of emotion on episodic and working memory, respectively, have identified the interaction of bottom-up/MTL-based and top-down/PFC-based mechanisms. (**a**) Regions such as medial/orbital PFC (mPFC/OFC) and insula are also involved in the processing of social relevance (see also Dolcos et al. 2012). (**b**) VAS consists of regions involved in basic emotion processing (AMY) and regulation (ventrolateral PFC [vlPFC]), portions of mPFC, and regions susceptible to emotional influence (lateral occipital cortices [LOC]). DES includes regions typically associated with cognitive control and maintenance of goal-relevant information (dorsolateral PFC [dlPFC] and lateral parietal cortex [LPC]). Notably, vlPFC seems to be involved in both the enhancing and the impairing effects of emotion on memory (Dolcos et al. 2013) (Figure adapted from Dolcos et al. (2012) and Iordan et al. (2013), with permission)

impairing effects of emotion can also be identified in EM (Dolcos and Denkova 2015). In typical WM tasks employed in brain imaging investigations of emotion-cognition interactions, participants are instructed to keep in mind a set of stimuli for the duration of a brief delay and then to respond whether or not a single stimulus presented immediately following the delay was part of the initial set. Negative emotional distraction presented during the delay period produces greater impairment in WM performance relative to nonemotional distraction (Dolcos and McCarthy 2006), thus suggesting a detrimental impact of emotional distraction on the maintenance of task-relevant information, resulting in WM impairment. These effects are typically associated with opposing patterns of activity in two neural systems: increased activity in a *ventral affective system* (VAS) mainly involved in emotion processes and decreased activity in a *dorsal executive system* (DES) mainly involved in executive processes (Fig. 1b) (Iordan et al. 2013). Activity in VAS and DES is strongly interconnected, such that increased activity in VAS regions, possibly as a result of reallocating processing resources by emotional distraction, temporarily reduces activity in DES regions, leading to WM impairment (Dolcos and McCarthy 2006).

In sum, emotion can exert beneficial or detrimental effects on memory, through different types of interactions between neural systems associated with bottom-up vs. top-down emotion processing. The bottom-up system involving mainly the MTL (AMY, HC) and the top-down system involving PFC regions contribute jointly to the beneficial effects of emotion on EM. By contrast, opposing relationships between the bottom-up (increased activity in VAS) and top-down (decreased activity in DES) systems lead to a detrimental impact of emotional distraction on WM. Importantly, these opposing effects of emotion on memory are not independent of one another, as demonstrated by evidence identifying both the dissociable and the overlapping mechanisms mediating these effects (Dolcos et al. 2013). For instance, activity in specific areas of the ventrolateral PFC (vlPFC) was associated with basic response to, successful coping with, and enhanced subsequent memory for emotional distraction, thus suggesting its pivotal role in emotion processing as part of both the bottom-up and top-down mechanisms (Dolcos et al. 2013). As discussed below, vlPFC activity also seems to be modulated by personality traits influencing emotional processes.

Role of Personality Traits in the Effect of Emotion on Episodic and Working Memory

Interest in personality and its role can be traced back to ancient Greek philosophers such as Galen of Pergamon, who tried to explain individual differences in character, and how they were reflected in different patterns of cognition and behavior (Stelmack and Stalikas 1991). However, clarification of these issues is a difficult endeavor, which requires a sophisticated and comprehensive methodology. Recent neuroscientific advancements have enabled a comprehensive brain-personality-cognition approach, which has yielded insights into the neural systems that govern how emotional memories are processed and how changes in these systems are associated with different personality traits. Clarification of the role of individual differences in the effect of emotion on memory is essential, as it allows better understanding of the underlying mechanisms in healthy functioning and of their changes leading to dysfunctional emotion-cognition interactions, as typically observed in affective disorders. This section discusses evidence regarding the role of personality linked to more general (extraversion, neuroticism, anxiety) and specific (habitual ER) traits affecting various aspects of emotion processing and memory.

Role of Extraversion, Neuroticism, and Anxiety

Some personality traits are associated with particular biases in attention and emotion processing. For instance, extraverts tend to exhibit a *positive affective bias* in cognition, as reflected in greater attention to positive than to negative stimuli (Derryberry and Reed 1994), and longer reaction times when responding to positive relative to neutral words (Haas et al. 2006). In contrast, individuals with high neuroticism or anxiety experience negative emotions more frequently and intensely on a daily basis (Ormel et al. 2013) and thus tend to exhibit a *negative affective bias* in cognition (Bishop and Forster 2013). Moreover, higher levels of neuroticism and anxiety are also linked to inefficient executive control (e.g., difficulty in inhibiting attention to irrelevant stimuli; Eysenck et al. 2007) and engagement of maladaptive coping mechanisms (Bishop and Forster 2013; Ormel et al. 2013).

These findings suggest that extraversion is associated with positive outcomes, whereas neuroticism and anxiety are characterized by dysfunctional emotion-cognition interactions at different levels. Given that the latter traits are considered important predictors of various forms of psychopathology, including mood and anxiety disorders (Ormel et al. 2013), it is important to clarify how the neural mechanisms underlying the enhancing and the impairing effects of emotion on memory differ between individuals with different personality traits, which in turn are associated with unique affective biases. Previous behavioral and brain imaging studies have documented the influence of these more general personality traits on particular emotional memory biases. Specifically, extraversion has been associated with greater recall of positive memories (Mayo 1983) and with maintaining a positive state following retrieval of positive personal memories (Denkova et al. 2012). A positive affective bias in memory associated with extraversion has been linked to greater AMY activity during emotional encoding (Haas and Canli 2008). Moreover, extraversion is also associated with indices of WM performance (Gray and Braver 2002) and efficiency (Lieberman 2000) and with decreased activity in executive control regions (e.g., lateral PFC) during WM tasks, thus suggesting more efficient and less effortful WM processing among extraverts (Gray et al. 2005).

In contrast, neuroticism is associated with a tendency to recall negative information (Bradley and Mogg 1994), which also applies to personal memories for real-life events (i.e., autobiographical memories [AMs]), as shown by an increased proportion of recollecting negative AMs in men and frequency of rehearsing negative AMs in women (Denkova et al. 2012). At the neural level, neuroticism influences the mechanisms involved in the effect of emotion on attention and memory (Ormel et al. 2013). The negative affective bias in emotional memory associated with neuroticism might be due to greater activation of a network of brain regions involved in attentional processes, driven primarily by increased sensitivity of the AMY to negative information during memory encoding (Haas and Canli 2008). Indeed, highly neurotic individuals showed greater AMY and HC activity when learning associations between fearful and neutral stimuli, which in turn enhanced subsequent memory for the neutral stimuli learned in association with the fearful ones (Hooker et al. 2008).

Similarly, trait anxiety is associated with enhanced encoding and retrieval of negative stimuli (Russo et al. 2006) and influences various aspects of EM, from AM to *prospective* memory (PM: ability to imagine and simulate future events and scenarios; Schacter et al. 2008). Highly anxious individuals have difficulties suppressing the impact of negative personal memories, as shown by a reduction in the fading of emotional experience associated with recollection of negative AMs over time (Walker et al. 2014), and also show impairment in PM (Kliegel and Jäger 2006). At the neural level, trait anxiety seems to influence the mechanisms involved in emotional learning, including AMY activity. For instance, highly anxious individuals showed greater AMY activity upon exposure to items previously learned in association with negative emotional material (Eden et al. 2015). Taken together, these findings suggest that neuroticism and anxiety are associated with increased sensitivity in the bottom-up mechanisms involved in emotional memory, resulting in enhanced encoding and retrieval of negative associations.

In addition to their link to EM, neuroticism and trait anxiety are also associated with impaired WM functioning, which has been linked to unsuccessful suppression of intrusive thoughts, in neuroticism (Munoz et al. 2013), and to a relative inability to filter out from WM storage threat-related cues that are not relevant to the task at hand, in anxiety (Stout et al. 2013). Evidence links neuroticism and anxiety to inefficient recruitment of a network of brain regions involved in top-down WM processing (Basten et al. 2012; Dima et al. 2015). For instance, a WM-related increase in functional connectivity (an index of how strongly activity in two brain regions increases or decreases together) between the dorsolateral PFC (dlPFC) and vlPFC was associated with higher trait anxiety (Basten et al. 2012). This suggests that the dlPFC and vlPFC are not only involved in WM processes at a general level but are also susceptible to modulation by personality.

Moreover, neuroticism and trait anxiety also seem to influence the dynamics of connectivity within and between networks of brain regions involved in emotion and executive processing, even when people are not explicitly performing tasks (i.e., at a *resting* state). This so-called *resting-state functional connectivity* is a powerful measure that allows comprehensive understanding of the brain as a constellation of functionally unique yet highly interactive networks and therefore has gained a considerable interest in neuroscientists and psychologists over the past decade (Power et al. 2011). Regarding alterations in the brain's resting-state connectivity linked to personality differences, neuroticism was shown to be associated with decreased connectivity within the top-down executive network and with increased connectivity in the bottom-up emotion-processing network (Carballedo et al. 2015). Moreover, trait anxiety was associated not only with decreased connectivity between the AMY and the top-down executive/attention network but also with increased connectivity between the AMY and the bottom-up attention network (He et al. 2016). This is consistent with the *attentional control theory* (Eysenck et al. 2007), which posits that anxiety disrupts the balance between the top-down vs. bottom-up attentional systems in the brain.

Overall, extant evidence highlights the robust influences of extraversion, neuroticism, and anxiety on emotion and memory processes. First, extraversion is linked to enhanced memory encoding and retrieval of positive information, whereas neuroticism and anxiety are linked to enhanced processing of negative information. These effects are associated with greater activation of the bottom-up mechanisms involved in emotional memory, as reflected in increased AMY (and HC) engagement during emotional memory encoding, suggesting a role of the bottom-up mechanisms in the specific memory biases associated with these personality traits. Second, extraversion is associated with better WM performance, along with more efficient engagement of top-down WM-related brain regions. By contrast, neuroticism and anxiety are associated with relatively impaired WM processing, linked to reduced activation or inefficient engagement of the top-down executive network, coupled with greater activation of the bottom-up emotion-processing network. Modulation of neural connectivity by neuroticism and trait anxiety further suggests dysfunctional interactions of the bottom-up and top-down mechanisms involved in emotion processing and executive control, in which vlPFC may play a pivotal role. This is consistent with evidence linking neuroticism and trait anxiety to inefficient ER (Bishop and Forster 2013; Ormel et al. 2013).

Role of Habitual ER

Successful ER is critical in everyday life, as it is established that the ability to cope adaptively with emotionally challenging situations is vital for physical and mental health (Gross 2008). Therefore, clarification of how different ER strategies influence memory encoding and retrieval has important clinical ramifications for helping people cope more adaptively with emotional challenges. Extant evidence shows that ER, either instructed experimentally or engaged habitually, can influence the effect of emotion on cognition. Two ER strategies studied most commonly in relation to memory and personality are *cognitive reappraisal* (reassessing the meaning of situations or thinking more positively) and *expressive suppression* (decreasing emotionally expressive behavior) (Gross 2008). Reappraisal, which is positively associated with extraversion and negatively with neuroticism, leads to improved emotional states and overall increased psychological well-being (Gross and John 2003). Suppression, which is negatively associated with extraversion, is linked to enhanced negative affect and increased vulnerability to anxiety symptoms (Llewellyn et al. 2013).

Reappraisal seems to have little to no effect on EM in general, whereas suppression impairs subsequent memory for emotional material (Richards and Gross 2000). Habitual engagement of suppression has been linked to decreased confidence in memory accuracy and reduced experience of sensory and emotional details upon AM retrieval (Rubin and Seigler 2004), along with increased recollection of negative AMs and negative post-retrieval emotional state in women (Denkova et al. 2012). In contrast, habitual engagement of reappraisal is associated with a bias toward positive AMs (Denkova et al. 2012). Brain imaging evidence regarding the effect of habitual ER on EM is still sparse. However, available evidence links habitual reappraisal with greater activity in top-down executive regions such as the PFC during the perception of negative stimuli (Drabant et al. 2009). This evidence is complemented by findings from previous studies of *instructed* reappraisal (i.e., participants were told to engage in reappraisal when presented with negative stimuli). In particular, increased activity in the PFC (including areas of vlPFC) was accompanied by co-activation of the AMY and HC, thus suggesting that the memory-enhancing effect of reappraisal may be linked to both AMY and PFC activity modulating that of HC during memory encoding (Hayes et al. 2010). By contrast, memory-impairing effects of suppression were associated with decreased activity in the HC (but not in the AMY), along with reduced connectivity between the HC and dlPFC. This suggests that suppression may induce decoupling of the bottom-up and top-down mechanisms involved in memory encoding, without strongly affecting emotional engagement (Binder et al. 2012).

Finally, habitual ER also influences WM, with transient engagement of reappraisal being linked to better WM performance (McRae et al. 2012) and with habitual engagement of reappraisal (but not suppression) being associated with increased dlPFC activity during a WM task (Scult et al.

2016). Furthermore, higher reappraisal and increased dlPFC activity during a WM task were both associated with reduced symptoms of anxiety and depression among individuals with higher levels of life stress (Scult et al. 2016). Collectively, these findings suggest a beneficial effect of reappraisal on WM functioning, which may in turn serve a protective role against symptoms of anxiety and depression.

Overall, the available evidence reviewed above identifies dissociable effects of habitual suppression and reappraisal on memory processes. Suppression seems to impair EM, and this effect may be linked to the role of suppression in modulating interactions between the bottom-up and top-down mechanisms involved in emotional memory. In contrast, reappraisal improves WM performance, and this effect is possibly mediated by the mechanisms involving the dlPFC. Notably, habitual reappraisal and dlPFC activation during WM processing were both linked to reduction in symptoms of anxiety and depression among highly stressed individuals. These findings have important implications for the development of interventions to facilitate the spontaneous engagement of adaptive ER strategies in affective disorders.

Conclusion

The overarching goal of the present chapter was to discuss available evidence regarding the role of extraversion, neuroticism, anxiety, and habitual engagement of ER strategies in the effect of emotion on EM and WM. Emerging evidence suggests that these factors can influence both the bottom-up and top-down mechanisms involved in the impact of emotion on EM and WM and that vlPFC may serve an important role in bridging these effects. Moreover, the role of vlPFC and dlPFC seems to be particularly important in effectively coping with emotions, and dysfunctional activity in and connectivity involving these regions is associated with symptoms of affective disorders.

Despite significant progress in clarifying the mechanisms regarding the role of personality traits in the impact of emotion on memory, several issues need clarification in future research. *First*, evidence shows that affective biases in emotional memory can be influenced by interactions between personality traits and other individual differences, such as sex (Denkova et al. 2012). Concomitant investigation of individual differences in multiple domains would be essential for a comprehensive understanding of the associated mechanisms. *Second*, relatively less is known about the mechanisms associated with ER strategies other than reappraisal and suppression, such as those involving attentional deployment (*distraction* and *focused attention*). Better understanding of the effects of these strategies on memory is important, given emerging evidence showing that interventions targeting attentional control (e.g. mindfulness meditation) are associated with greater recall of positive information, increased psychological well-being, and fewer symptoms of anxiety and depression (Roberts-Wolfe et al. 2012). *Third*, as reviewed above, personality traits can influence the dynamics of interactions within and between large-scale functional networks/systems in the brain. There is evidence (e.g., Iordan and Dolcos 2016) suggesting both overlaps and dissociations between the larger neural *systems* (VAS/DES) sensitive to task manipulations (Dolcos and McCarthy 2006) and the large-scale functional *networks* as identified by investigations of resting-state functional connectivity (Power et al. 2011). Further clarification of more subtle network-based dissociations within the larger neural systems would be needed. For instance, given the diverse role of vlPFC in emotion-cognition interactions as reviewed here, investigation of its functional dissociation through combinations of task manipulations and resting-state recordings would be important. Clarification of these issues has profound implications for understanding mechanisms of emotion-cognition interactions both in healthy functioning and in emotional disturbances.

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Cross-References

- ▶ Amygdala
- ▶ Emotion Regulation
- ▶ Extraversion
- ▶ Functional Magnetic Resonance Imaging (fMRI)
- ▶ Lateral Prefrontal Cortex (LPFC)
- ▶ Neural Networks
- ▶ Neuroscience of Personality and Individual Differences
- ▶ Neuroticism
- ▶ Trait Anxiety

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